# Stable isotope compositions of vertebrate remains of the Upper Cretaceous Iharkút fauna

László KOCSIS[1], T. VENNEMANN[1] & Attila ŐSI[2]

[1] *Institut de Minéralogie et Géochimie, University of Lausanne, UNIL – Humense, CH-1015 Lausanne, Switzerland*; [2] *Department of Paleontology, Eötvös University of Budapest, ELTE – Pázmány P. sétány 1/C, H-1117 Budapest, Hungary*

Fossil rich layers of the Upper Cretaceous fluviative deposits of Iharkút were discovered in 2000 and since then many vertebrate remains have been described (e.g. Ősi, 2004, 2005). To further characterize the habitat conditions for the vertebrates at the time, the stable carbon and oxygen isotope compositions of the fossils were analyzed.

Oxygen isotope compositions of biogenic phosphate in vertebrate fossils are frequently used as proxies of environment, climate (e.g., Vennemann & Hegner, 1998), or even thermo-regulation (e.g., Showers et al., 2002). In addition, carbon isotope compositions of bones and teeth, if preserved, represent tracers of feeding habitats (e.g. Koch, 1998). While some studies question the preservation of the original isotopic compositions of phosphatic remains (e.g. Kolodny et al., 1996), especially that of carbonate within phosphate (Iacumin et al., 1996), a good line of evidence for preservation of compositions is given by differences in the isotopic compositions of coexisting, ecologically distinct fossil taxa (Koch, 1998). With this in mind, many different taxa such as two kinds of fish teeth (Pycnodontiformes, Lepisosteidae); turtle plate fragments; Mosasauridae teeth and three groups of crocodiles (Alligatoroidea indet, *Doratodon* sp., Eusuchia indet.); rib fragment, armor plates and teeth of a newly described ankylosaur, the *Hungarosaurus tormai* (Ősi, 2005), and teeth of a theropod dinosaur were analyzed for oxygen ($\delta^{18}O_{phosphate}$, $\delta^{18}O_{carbonate}$, in ‰ VSMOW) and carbon isotope compositions.

The $\delta^{18}O_{carbonate}$ of different remains range between 23 and 25‰, without any systematic variation among the taxa. The same is true for $\delta^{13}C$ values (−4.5 to −8 ‰, VPDB), except for turtle plates and armors of ankylosaur that have slightly lower $\delta^{13}C$ values (−8 to −11 ‰). These data indicate that both oxygen and carbon isotopic compositions in structural carbonate of the phosphate might be altered.

All of the $\delta^{18}O_{phosphate}$ measurements show an average of 18±2 ‰, with a lower range for Mosasauridae and Pycnodontiformes teeth and some turtle plates (15.8 to 17.8 ‰) and higher values for some crocodile and theropod teeth (19 to 20 ‰). The oxygen isotope composition of the river water can be deduced from turtle bones (Barrick et al., 1999) and the calculated $\delta^{18}O_{water}$ values are −5.5±0.5 ‰ and −3.5±0.5 ‰, which provides temperature estimates of 10 to 32 °C on the basis of $\delta^{18}O_{phosphate}$ values of fish teeth formed in such waters (Kolodny et al., 1983).

Assuming most of the $\delta^{18}O_{phosphate}$ data are pristine, the lower $^{18}O/^{16}O$ of Pycnodontiformes and Mosasauridae can reflect depleted water oxygen isotopic compositions (large riverine or deeper water source) and/or higher temperature (shallow, surface water) in which these teeth developed. As both groups have a fully aquatic habitat they might have dominated the river ecosystem, occasionally migrating into shallow, warmer waters.

The higher $\delta^{18}O$ values of some crocodile teeth might point out that bones grew in water enriched in $^{18}O$ (local ponds, surface water enriched through evaporative processes), an interpretation that is supported by the preferred warm-temperature habitat of crocodilians (Marrwick, 1998). In the case of theropod dinosaurs, the high value might also reflect a drinking water composition enriched in $^{18}O$.

Alternatively, partial to complete alteration will lead to a homogenization of originally different isotopic compositions, which may explain why values converge to an oxygen isotopic composition of a common diagenetic fluid, which would be in equilibrium with an average phosphate of 18 ‰.

## References

Barrick, E.R., Fischer, G.A. & Showers, J.W. 1999. Oxygen Isotopes From Turtle Bone: Applications for Terrestrial Paleoclimates? *Palaios,* 14: 186-191.

Iacumin, P., Bocherens, H., Mariotti, A. & Longinelli, A. 1996. Oxygen isotope analyses of co-existing carbonate and phosphate in biogenic apatite: a way to monitor diagenetic alteration of bone phosphate? *Earth Planet. Sci. Lett.*, 142: 1-6.

Koch, L. P. 1998. Isotopic reconstruction of past environments. *Annu. Rev. Earth Palnet. Sci.*, 26: 573-613.

Kolodny, Y., Luz, B. & Navon, O. 1983. Oxygen isotope variations in phosphate of biogenic apatites, I. Fish bone apatite-rechecking the rules of the game. *Earth Planet. Sci. Lett.*, 64: 398-404.

Kolodny, Y., Luz, B., Sander, M. & Clemens, A.W. 1996. Dinosaur bones: fossils or pseudomorphs? The pitfalls of physiology reconstruction from apatitic fossils. *Palaeogeogr. Palaeoclimat. Palaeoecol.*, 126: 161-171.

Marwick, J.P. 1998. Fossil crocodilians as indicators of Late Cretaceous and Cenozoic climates: implications for using paleontological data in reconstructing paleoclimate. *Palaeogeogr. Palaeoclimat. Palaeoecol.*, 137: 205-271.

Ősi, A. 2004. The first dinosaur remains from the Upper Cretaceous of Hungary (Csehbánya Formation, Bakony Mts). *Geobios*, 37: 749-753.

Ősi, A. 2005. *Hungarosaurus tormai*, a new ankylosaur (Dinosauria) from the Upper Cretaceous of Hungary. *Journal of Vertebrate Paleontology*, 25: 370-383.

Showers, W.J., Reese, B. & Genna, B. 2002. Isotopic analysis of dinosaur bones – a new pyrolysis technique provides direct evidence that some dinosaurs were warm-blooded. *Analytical Chemistry*, 74: 143-150.

Vennemann, T.W. & Hegner, E. 1998. Oxygen, strontium, and neodymium isotope composition of fossil shark teeth as a proxy for the palaeoceanography and palaeoclimatology of the Miocene northern Alpine Paratethys. *Palaeogeogr. Palaeoclimat. Palaeoecol.*, 142: 107-121.